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(19)

(54) APPARATUS FOR THE TREATMENT OF FLUIDIZED MATERIAL

(71) We, ANHYDRO A/S a Danish joint stock Company of 8 Østmarken, 2860 Søborg, Denmark, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an apparatus for the treatment of fluidized material, having at least one perforated distribution plate arranged for the passage of a flow of gas for fluidizing a material above the distribution plate, and wherein the spaces above and below the distribution plate are sub-divided into a plurality of matching pairs of sections, with one section of each pair being above the distribution plate and the other below, by means of matching pairs of dividing plates extending across the distribution plate, the dividing plates above each distribution plate being so arranged that they can be removed away from abutment against the distribution plate.

Apparatus of this nature is used for the treatment of fluidized material, when various processes or partial processes are carried out in the individual sections. For instance, such an apparatus can be used for the granulation of a powdered material, which is moistened in the fluidized state and agglomerates in a first section, whereupon the agglomerated material in the fluidized state is dried in a second section, finally to be cooled in a third section. Also, apparatus of this nature can be used for drying processes carried out in several stages, and in which, for example, a part of the drying is carried out in a first stage in a first section at one temperature of the drying air, a second stage of the drying process proceeds in a second section at another temperature, and a third stage of the drying process is effected in a third section at a third temperature, after which the material may be cooled in a fourth section. In the individual sections the layer of fluidized material will have substantially the same height as that of the dividing plates above the distribution plate; when the apparatus is to be emptied, it is therefore necessary to be able to remove the dividing plates from abutment with the distribution plate so that the material in the different sections can be passed freely towards the materials discharge opening of the apparatus. Such removal of the dividing plates from the distribution plate is usually effected by swinging them away from abutment on the distribution plate by pivoting about an axis extending in the longitudinal direction of the dividing plate, the removal being effected by means of suitable members operable from outside.

With apparatus of this type, which is to be used for a specific treatment of one material, it is possible to position the matching pairs of dividing plates to obtain the optimum dimensions of the individual sections. However, if it is desired to use the same apparatus for more than one process or to treat different materials, the problem may arise that the dimensions of the various sections do not in each case correspond to the optimum conditions of operation. That is that a reduced yield of production and/or a reduced quality of the product may result. This problem may be further illustrated by way of an example:

An apparatus for fluidized agglomeration of powdered material consists of a first section for moistening and agglomeration, a second section for drying, and a third section for cooling the material. In the agglomeration of a first material a moistening operation may require adding 10 per cent of water to the dry matter in the first section. This quantity of water is subsequently evaporated in the second section at a dry-

ing temperature of e.g. 80°C in the fluidized layer, and the material is then cooled in the third section to 40°C. For this purpose the second and the third sections may e.g. be of the same size.

If the same apparatus is then used for the agglomeration of another material, to which 10 per cent of moisture again is added in the first section, but for which material a drying temperature of only 75°C is permissible in the fluidized layer in the second section, the drying capacity of the second section (in terms of kg. per square metre of drying area per hour) is reduced, e.g., by about 20 per cent. On the other hand, the material is cooled to an unduly low temperature in the third section, partly on account of the lower drying temperature in the second section and partly on account of the reduced flow of material.

According to the present invention, apparatus for the treatment of fluidized material comprises a perforated distribution plate arranged for the passage therethrough of gas for the fluidization of a material deposited thereabove, the adjacent spaces above and below said distribution plate being divided into a plurality of matching pairs of sections, with one section of each pair being above the plate and the other below, by means of matching pairs of substantially parallel dividing plates projecting away from and extending across the distribution plate, one plate of each pair being above the distribution plate and the other being below, said dividing plates above the distribution plate being removable from abutment against the distribution plate, and both dividing plates of at least one of the matching pairs being so arranged that the position of their abutment on the distribution plate can be fixably displaced in the direction normal to their abutting edges and substantially parallel to the distribution plate whereby the dimensions of the adjacent sections of said spaces above and below the distribution plate are varied.

By arranging the apparatus in this way the dimensions of the various sections can be so adapted that the optimum conditions of operation are obtained with different treatments and/or different materials.

In the case of the example mentioned above it would thus be possible with apparatus according to the invention and having sufficient range of movement for the dividing plates to increase the capacity of the apparatus by about 20 per cent by shifting the dividing plates between the second and the third sections in such a way that the area of the former is increased by about 20 per cent and the area of the latter is correspondingly reduced.

Arranging the dividing plates below the distribution plate so that their positions can be altered presents no great difficulties in design, as these dividing plates can simply be displaceably mounted in rails on the lateral walls of the apparatus. However the arrangement of the dividing plates above the distribution plate does present some problems. This is partly because above the distribution plate the air is mixed with particles of material, so that leaks must be avoided, and partly because these dividing plates must be capable not only of being moved relative to the distribution plate, but they must also be capable of being removed from contact with it. These problems are overcome in a preferred arrangement in which at least one of the dividing plates above the distribution plate is removable from abutment against the distribution plate by pivoting about an axis extending parallel to the dividing plate and across the distribution plate. A dividing plate above the distribution plate which is fixably displaceable in the direction normal to its abutting edge and parallel to the distribution plate may be mounted for movement in said direction from an arm which extends in that direction and which is fixably displaceable along its longitudinal axis. Preferably the arm is fixably attached tansversely to a rotatable shaft. This arrangement ensures that, irrespective of the position, the dividing plates occupy as a consequence of their displacement relative to the distribution plate, they can always be approximately at right angles to it when abutting against it. Thus dead "pockets" in the fluidized layer adjacent to the dividing plates are avoided. Such pockets would reduce the effective dimensions of the sections concerned, and the height of the fluidized layer will thus remain constant at different settings of the dividing plates.

The invention will now be explained in more detail, with reference to the accompanying drawings, wherein

Fig. 1 schematically shows a longitudinal section through one embodiment of an apparatus according to the invention; and

Fig. 2 shows on an increased scale a part of an alternative construction.

Fig. 1 shows an apparatus, generally denoted 1, for fluidized agglomeration of powdered material. The apparatus comprises a perforated distribution plate 2 with the spaces above and below it subdivided by means of upper dividing plates 3 and 4 and lower dividing plates 6 and 7 into three sections A, B and C above the distribution plate and corresponding sections D, E and F below. Each compartment D, E and F is connected to a fan 8, 9 and 10, respectively, the fan 9 communicating with

the compartment E via a heating unit 11. A moistening unit 12 is in connection with section A, and a materials discharge device 13, 13*a* adjoins section C. Further, the apparatus 1 has a powder bin 14 which is in connection with the apparatus via a powder inlet 15. A vent pipe 16 is connected to an air suction fan 17 via a powder sepapator 18 which can be connected to the powder inlet 15 via a valve 19.

The upper dividing plates 3 and 4 are attached to offset arms 20 and 21, respectively, which extend substantially in the direction of flow of the material through the apparatus 1 that is substantially normally to the dividing plates. In the embodiment shown two of these arms 20 and 21 are provided for each dividing plate 3, 4, one arm being placed on each side of the apparatus 1. The arms 20 and 21 are displaceably attached in through-going borings in shafts 22 and 23, respectively. The shafts extend transversely through the apparatus 1 parallel to and across the distribution plate 2, and are arranged to be rotated from outside. The arms 20 and 21 may be moved relative to the respective shafts in the directions indicated by arrows *b*. An upper end plate 5 is attached to a shaft 24 extending across the distribution plate like the shafts 22 and 23 and is similarly rotatable from outside.

The lower dividin plates are displaceably attached in the lower part of the apparatus 1 by means of attachment members provided in longitudinal rails, not shown, in the lateral walls of apparatus 1, so that the dividing plates 6 and 7 can be shifted in the directions shown by arrows *a*.

Fig. 2 shows on an increased scale a part of a distribution plate 2*a*, a lower dividing plate 6*a*, and an upper dividing plate 3*a* attached to arms 20*a* which in this embodiment are formed as straight, round sectioned bars, only one of the arms is shown. The arms 20*a* pass through bores 25 in a shaft 22*a*, which extends transversely through the apparatus, and can be fixed in the bores 25 by means of respective set screws 26.

Inspection and cleaning doors, not shown, are provided in the lateral walls of apparatus 1 above the shafts 22 and 23. These doors also provide access so that the arms 20 and 21 can be displaced and fixed relative to the shafts 22 and 23. The doors have tight-fitting but easily detachable covers.

Alternatively, the arms 20 and 21 can be arranged for shifting from outside, e.g. by means of a rack-and-pinion mechanism.

The apparatus operates as follows:

The powdered material which is to be agglomerated is supplied from the bin 14 via the powder inlet 15 to section A, where it is fluidized in the flow of air supplied from the fan 8 through the compartment D and the distribution plate 2. Simultaneously, the powdered material is moistened by means of the moistening unit 12 so that it forms agglomerates. When the fluidized layer reaches a height corresponding to the upper edge of the dividing plate 3, the agglomerated particles will passs into section B, where they are fliudized and dried in the flow of air supplied from the fan 9 via the heating unit 11 and the compartment E. When the fluidized layer in section B reaches a height corresponding to that of the dividing plate 4, the dried and hot agglomerated particles will be passed into section C, where they are fluidized and cooled in the flow of air supplied from the fan 10 through the compartment F. When the fluidized layer in section C reaches a height corresponding to that of the end plate 5, the cooled, agglomerated particles will pass into the discharge section 13, from where they can be removed through a screen 13*a*. Powder particles not agglomerated are taken by the suction air through the vent pipe 16 to the powder separator 18, from where they can be re-directed to the powder inlet 15 through the valve 19. The suction air is removed through the fan 17.

During operation all the sections A, B and C are filled with fluidized material to the upper edges of the plates 3, 4 and 5. When the apparatus 1 is emptied, the dividing plates 3 and 4 are raised by turning the shafts 22 and 23 from outside. Raised position 4 for the dividing plate 4 is shown dotted in figure 1. Simultaneously, the end plate 5 is turned into a horizontal position by rotation of the shaft 24 from outside. The powdered material can be removed readily through the discharge section 13.

When the apparatus according to the invention is to be adapted for other conditions of operation, the first stage is to liosen the dividing plates 6 and 7 and move them into positions giving the desired dimensions of compartments D, E and F corresponding to the desired new dimensions of sections A, B and C; the dividing plates 6 and 7 are fixed in the new position. Now the inspection and cleaning doors on the sides of the apparatus 1 above the shafts 22 and 23 are removed, the arms 20 and 21 are loosened, and the dividing plates 3 and 4 are moved so as to provide the desired dimensions of the sections A, B and C. Thereafter the arms 20, 21 are again fastened in the shafts 22 and 23, the doors are closed, and the apparatus is again ready for use.

If only one set of the matching pairs of dividing plates 3 and 6 or 4 and 7 needs to

be shifted to obtain the desired dimensions of the sections, as was the case in the example originally given, only that pair is moved.

As mentioned in the foregoing, the apparatus may be arranged so that the arms 20, 21 can also be shifted from outside. As the dividing plates 6 and 7 are correspondingly arranged to be shifted from outside, this enables the operator if necessary to change the dimensions of sections A, B and C during operation.

The apparatus described above has one distribution plate 2 divided into matching pairs of sections by movable matching pairs of substintially parallel dividing plates 3 and 6, and 4 and 7. It will be understood that the apparatus may have more than one distribution plate, and that each distribution plate may be divided into matching pairs of sections by one or more matching pairs of movable dividing plates.

WHAT WE CLAIM IS:—

1. Apparatus for the treatment of fluidized material, comprising a perforated distribution plate arranged for the passage therethrough of gas for the fluidization of a material deposited thereabove, the adjacent spaces above and below said distribution plate being divided into a plurality of matching pairs of sections, with one section of each pair being above the plate and the other below, by means of matching pairs of substantially parallel dividing plates projectisg away from the extending across the distribution plate, one plate of each pair being above the distribution plate and the other being below, said dividing plates above the distribution plate being removable from abutment against the distribution plate, and both dividing plates of at least one of the matching pairs being so arranged that the position of their abutment on the distribution plate can be fixably displaced in the direction normal to their abutting edges and substantially parallel to the distribution plate whereby the dimensions of the adjacent sections of said spaces above and below the distribution plate are varied.

2. Apparatus according to Claim 1, wherein at least one of the dividing plates above said distribution plate is removable from abutment against the distribution plate by pivoting about an axis extending substantially parallel to the dividing plate and substantially parallel to and across the distribution plate.

3. Apparatus according to Claim 2, wherein a dividing plate above the distribution plate which is fixably displaceable in the direction normal to its abutting edge and substantially parallel to the distribution plate is mounted for movement in said direction from an arm which extends in that direction and which is fixably displaceable along its longitudinal axis.

4. Apparatus according to Claim 3, wherein said arm is fixably attached transversely to a rotatable shaft.

5. Apparatus for the treatment o. fluidized material, substantially as hereinbefore described with reference to the accompanying drawings.

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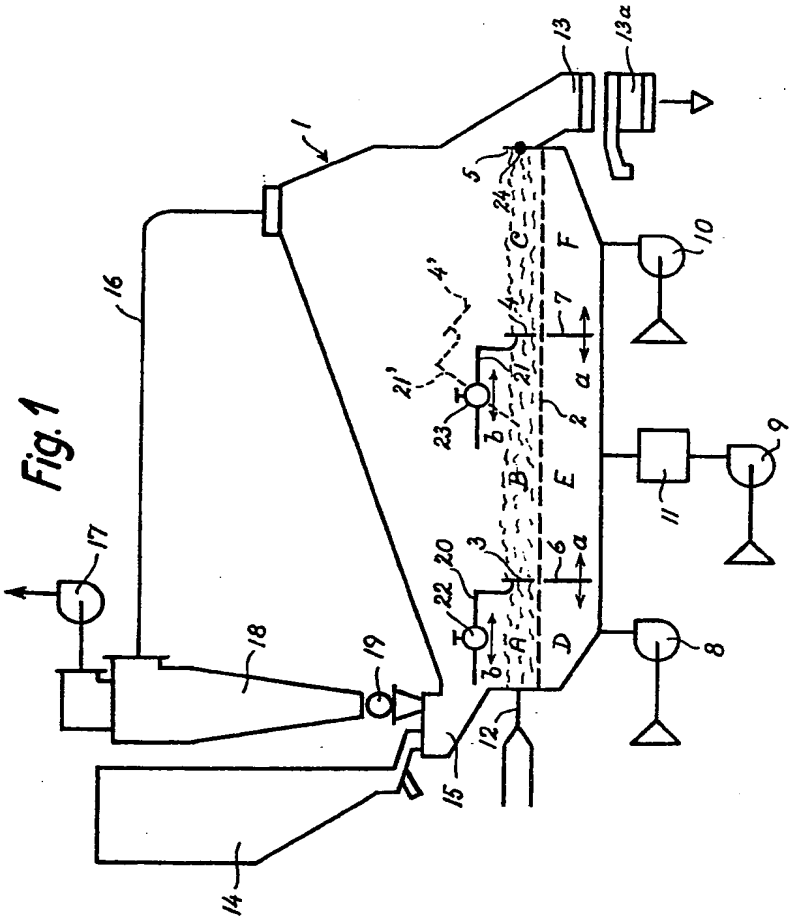
Sheet 1



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Sheet 2

Fig. 2